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SOURCE Doklady Akademii Nauk, SSSR, Novaya Seriya, Vol LXXIV, No 5, 1950, pp 917-921.

THE PROBLEM OF ELEMENTS 97 and 98

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Submitted 13 Jul 1950
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Shortly after the recently published report on the obtaining of element 97 at the University of California (S. G. Thompson, A. Ghiorso, and G. T. Seaborg, Phys Rev, Vol LXXVII, 838, 1950), another report was received on the synthesis of the following element 98. The isotope obtained, 98^{244}, has alpha-radioactivity with a half-life of 43 minutes (G. T. Seaborg, Phys Rev, Vol LXXVIII, No 3, 1950). The properties of the isotopic nuclei of element 97 were long ago described accurately in the USSR on the basis of the laws governing the periodic system of atomic nuclei (A. P. Znoyko, DAN, Vol LXIX, No 2, 1949 [redacted]. The agreement of experimentally obtained data with the properties predicted by A. P. Znoyko for isotopes of these elements is shown in Table 1.

50X1-HUM

Table 1. Comparison of Experimental and Predicted Data for Elements 97 and 98

Elements 97 and 98	Predicted From Periodic System of Atomic Nuclei			Obtained Experimentally		
Isotope	97^{243}	97^{244}	98^{244}	97^{243}	97^{244}*	98^{244}
Type of radiation	K	K		K	K	
Half-life	hrs	hrs	min	4.8 hr		43 min

*The K-capture determined experimentally as having a half-life of 4.8 hours applies to isotope 97^{243} or to 97^{244}.

Recently, Mendeleyev's periodic law has been developed with the purpose of relating the periodically varying properties of atomic nuclei with the quantitative characteristics of the nuclei. As is well-known, A. P. Znoyko succeeded in finding a relationship between the variable properties of nuclei, their specific charge,

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50X1-HUM

and structure. On the basis of this relationship, he constructed a periodic system of isotopic nuclei which is the most advanced development of the basic ideas of Mendeleyev's periodic law (A. P. Znoyko, DAN, Vol LXVIII, No 5, 1949

50X1-HUM

The periodic system of atomic nuclei not only reveals a regular relationship among the periodically varying properties of the known isotopic nuclei, but also permits us to predict many isotopic nuclei unknown at present. In particular, for element 97 it was predicted that this element should have isotopes with masses 243 and 244 which must be unstable and characterized by K-capture with a half-life measured in hours.

In their recently published article, Seaborg, Thompson, and Ghiorso stated that element 97 was obtained by the action of alpha-particles upon an americium isotope, Am^{241}_{95}. The nuclear reaction was described by the equation:

$$Am^{241}_{95} + He^{4}_{2} = 97^{243} + 2n^{1}_{0} \text{ or}$$

$$Am^{241}_{95} + He^{4}_{2} = 97^{244} + n^{1}_{0} .$$

It was established that the given isotope exhibits K-capture with a half-life equal to 4.8 hours. It was proposed that this element be called berkelium and given the symbol Bk.

Thus, the results obtained by the experimenters agree completely with the data predicted by A. P. Znoyko.

The predictions, however, related not to one, but to several isotopes of element 97, which indicates the great effectiveness of Mendeleyev's method of prediction and its important application to atomic and nuclear physics.

The periodic system of atomic nuclei permits us to determine the properties of all isotopes of elements 97 and 98 (see Table 2).

Table 2

Element 97											
Isotopic mass	240	241	242	243	244	245	246	247	248	249	250
Type of radio-active decay	K	K	K	K	K						
Half-life	min	min	min	hrs	hrs	days	yrs	yrs	yrs	yrs	yrs
Element 98											
Isotopic mass	243	244	245	246	247	248	249	250	251		
Type of radio-active decay	K		K								
Half-life	min	min	days	hrs-days	yrs	days	yrs	yrs	yrs		

The periodic system of elements, constructed on the basis of periodically varying values of specific charge, defines the actinides as clear homologs of the lanthanides. The new elements 97 and 98 chemically must be homologs of elements 65 and 66, Terbium and dysprosium.

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50X1-HUM

Consequently, the properties which are observed for the series Eu, Gd, Tb, and Dy must also hold for elements of the series Am, Cm, 97, and 98.

As with Terbium, the main valent states of element 97 must be + 3 and + 4 and the former state should be most stable. The element may have 8 and 7 electrons in the 5f level. Element 98 is a chemical analog of Dy and has a valency of 3.

It is very difficult in practice to isolate and study compounds of element 97 with mass 243 because the half-life of this isotope is extremely short. Therefore, the chemical nature of element 97 should be studied through its isotopes with masses 246, 247, 248, and 249, which have longer half-lives. For study of element 98, the long-lived isotope with mass 250 might be obtained.

The effectiveness of Mendeleyev's method is clearly apparent from the brief data given above on predicting the properties of elements 97 and 98. This method will stimulate the development of the chemistry of atoms and nuclear physics.

Element 96 has been given the name "curium." Element 96 is followed by element 97, which was predicted on the basis of the discovery of the periodic system of atomic nuclei with the help of the Mendeleyev method 2 years before it was actually obtained. We propose, therefore, that this element be called "mendeleyevium" and given the symbol Md.

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